PLC-001-LP

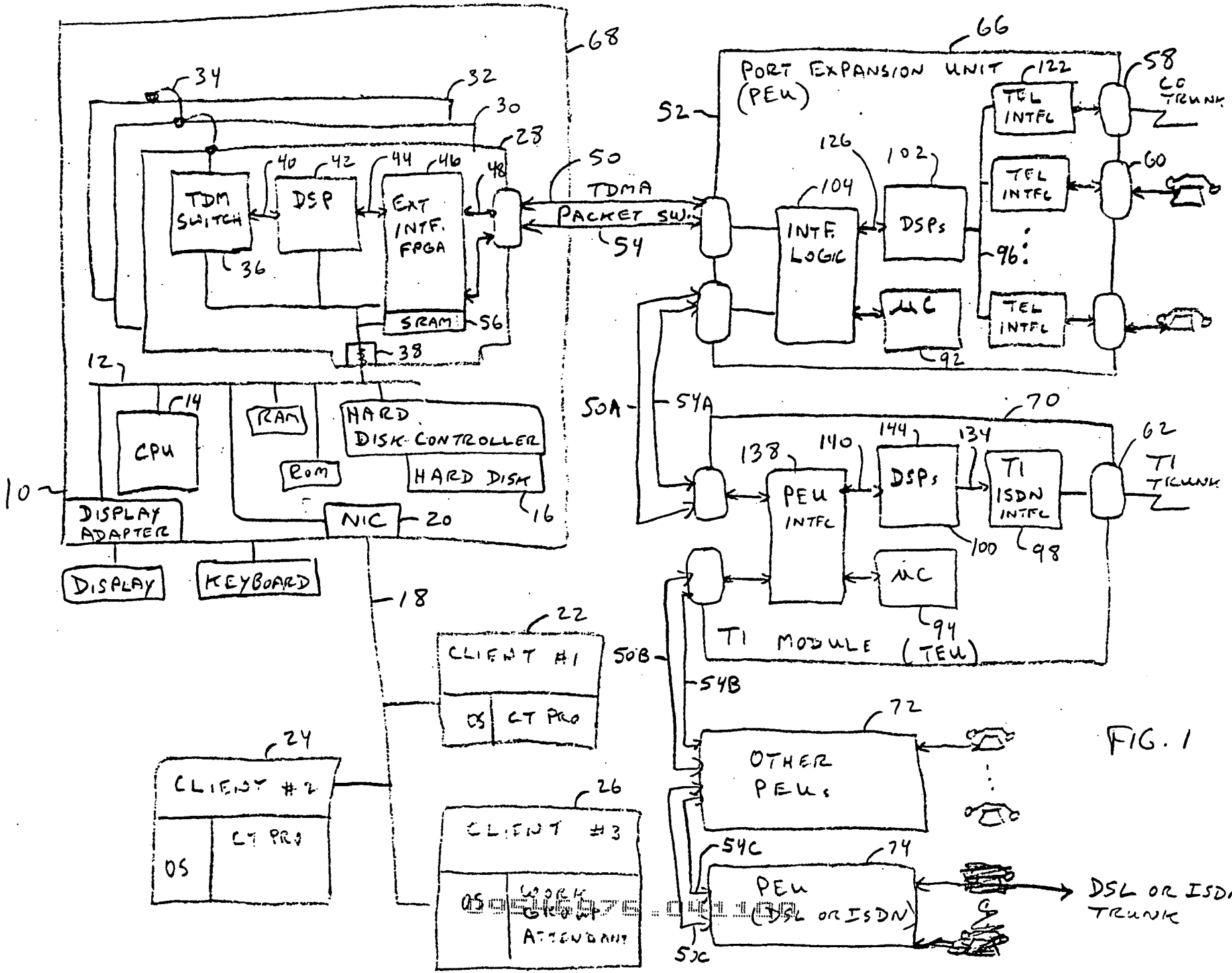
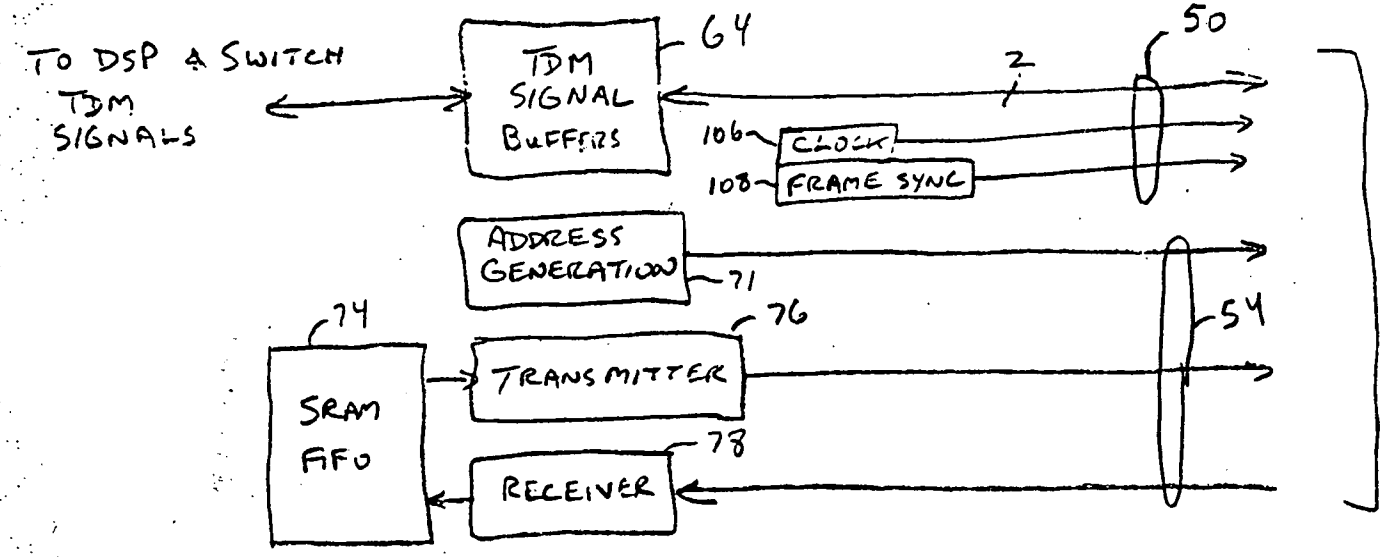


FIG. 1



EXTERNAL INTERFACE IN SERVER

FIG. 2

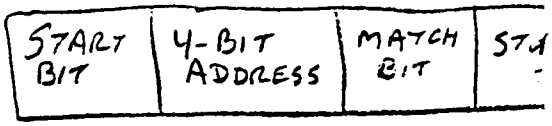


FIG. 4

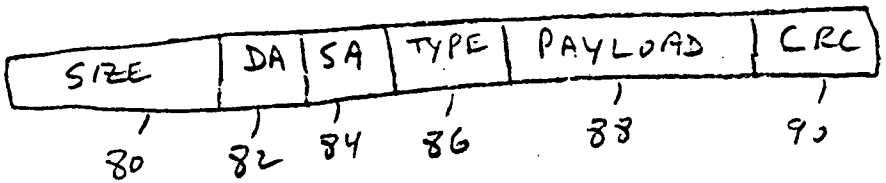


FIG. 3

09546076_041100

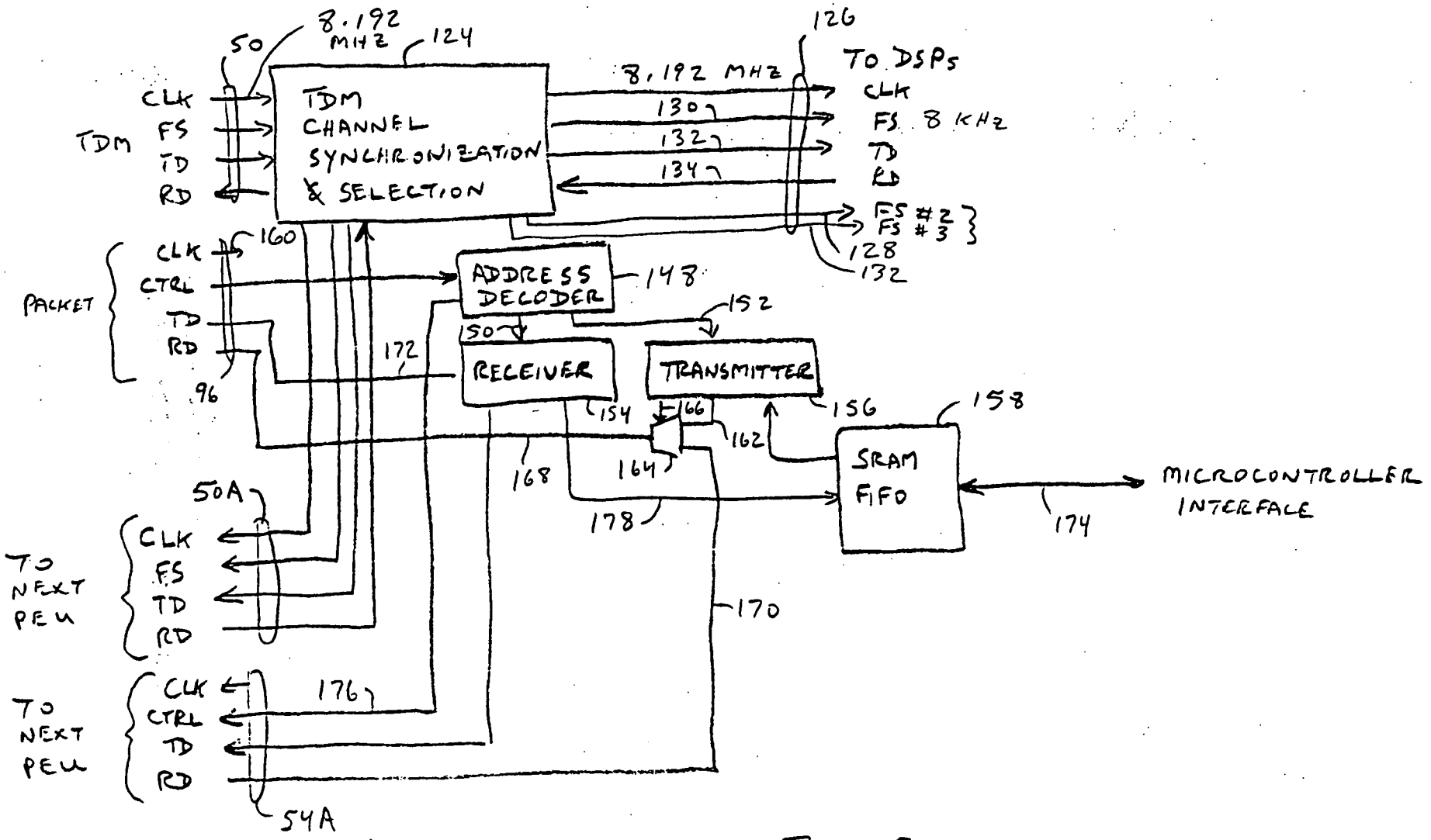
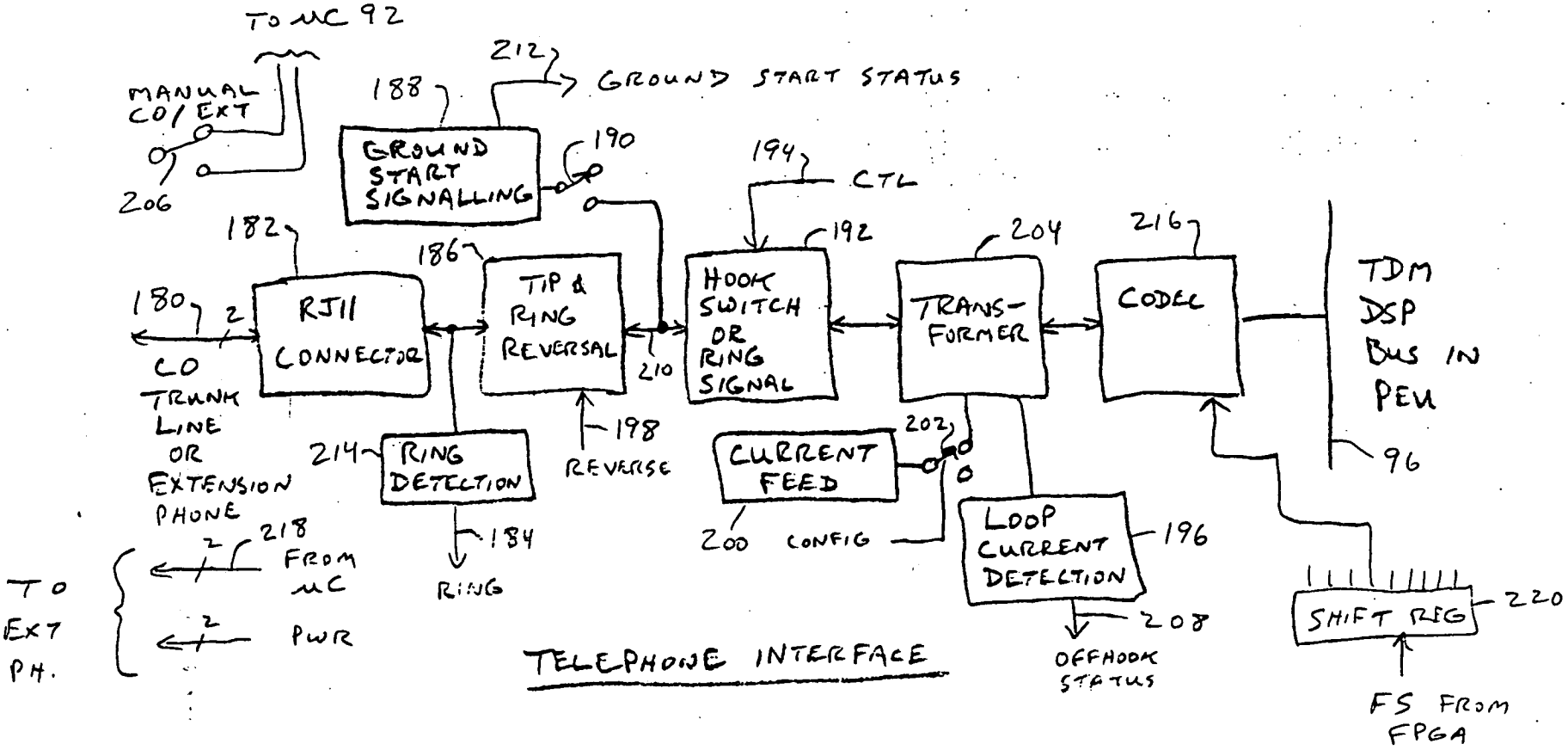


FIG. 5

PORT EXPANSION UNIT INTERFACE

0951693T6 _041100



TELEPHONE INTERFACE

FIG. 6

PEU Processing

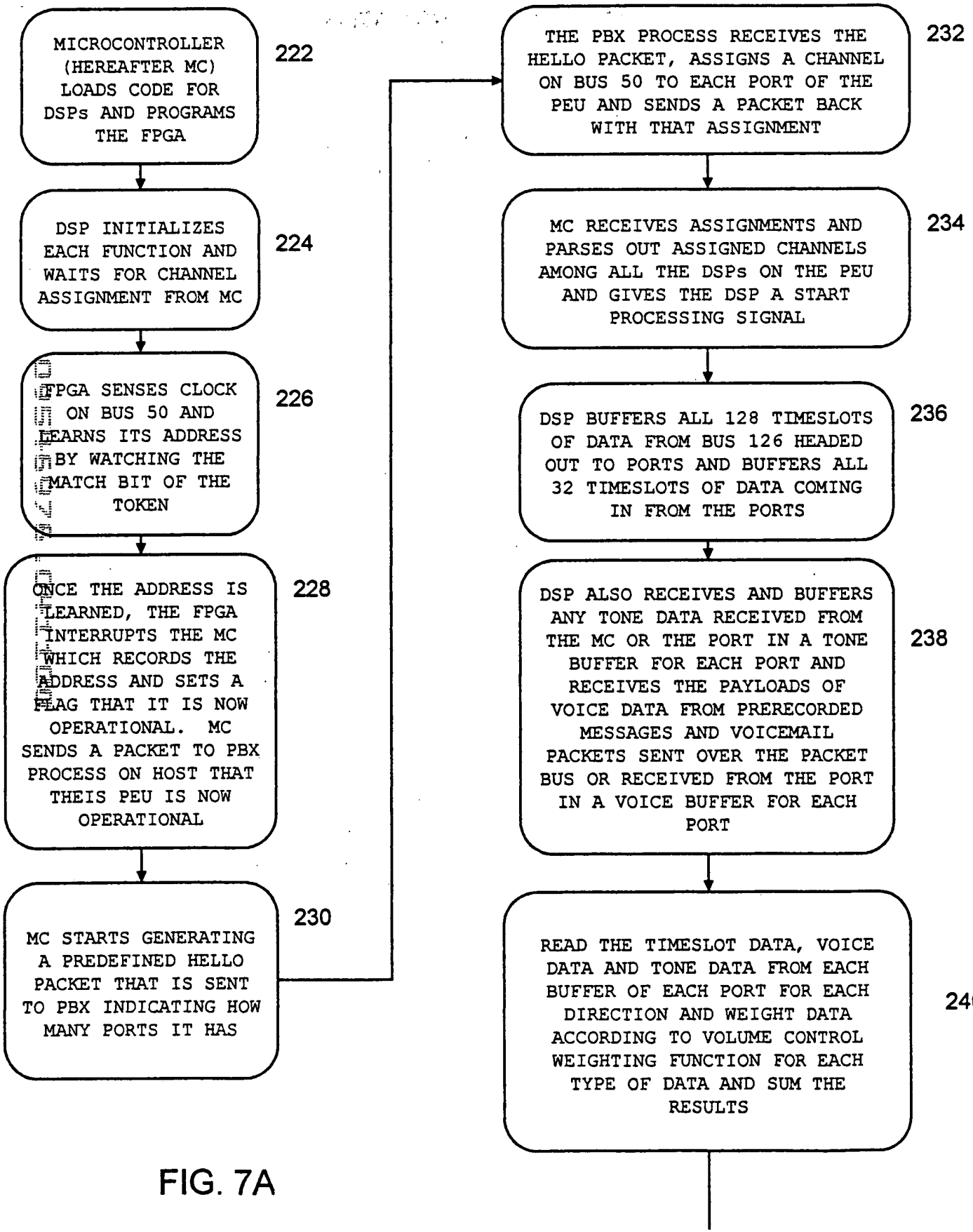


FIG. 7A

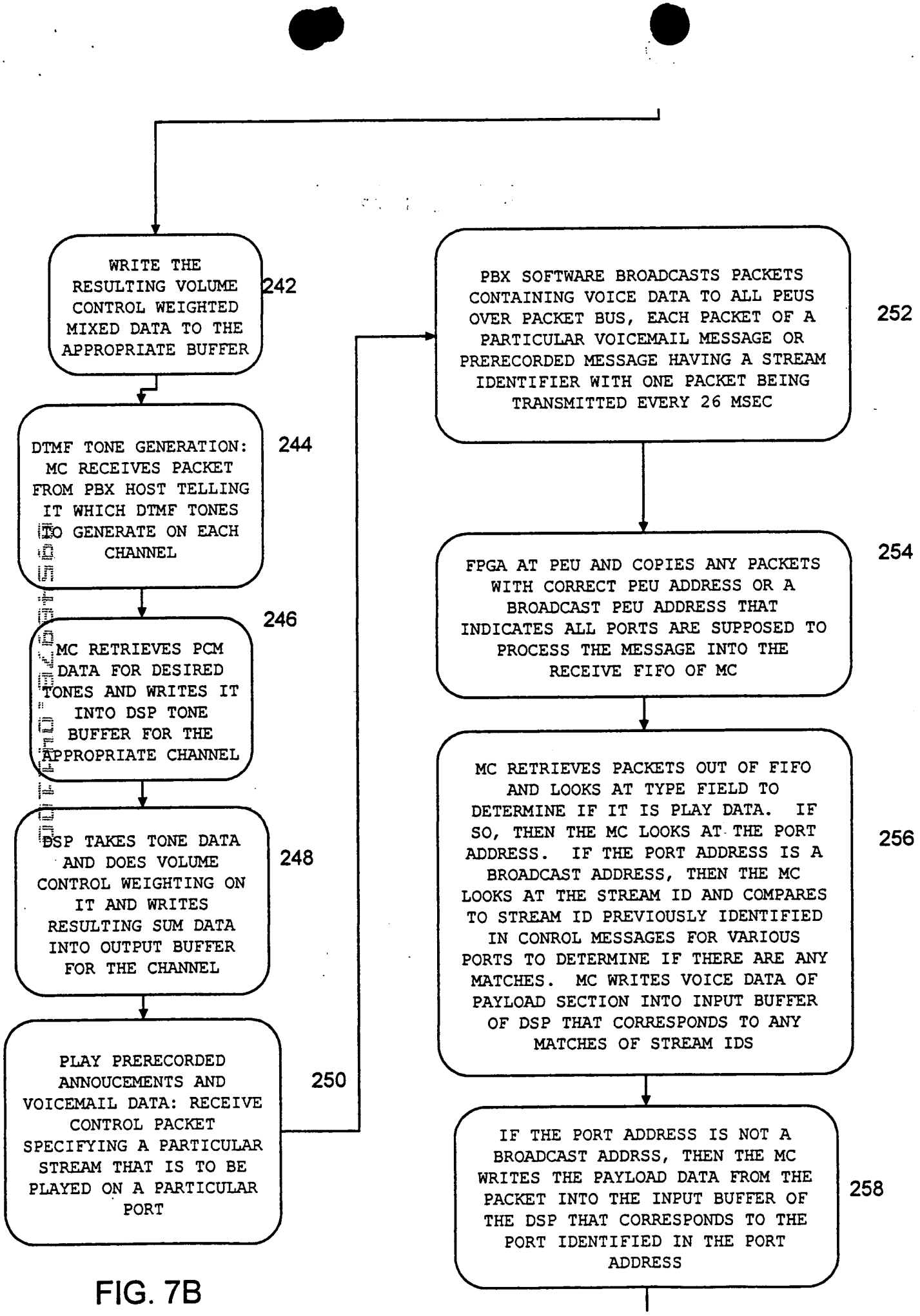

WRITE THE RESULTING VOLUME CONTROL WEIGHTED MIXED DATA TO THE APPROPRIATE BUFFER
242
DTMF TONE GENERATION: MC RECEIVES PACKET FROM PBX HOST TELLING IT WHICH DTMF TONES TO GENERATE ON EACH CHANNEL
244
MC RETRIEVES PCM DATA FOR DESIRED TONES AND WRITES IT INTO DSP TONE BUFFER FOR THE APPROPRIATE CHANNEL
246
DSP TAKES TONE DATA AND DOES VOLUME CONTROL WEIGHTING ON IT AND WRITES RESULTING SUM DATA INTO OUTPUT BUFFER FOR THE CHANNEL
248
PLAY PRERECORDED ANNOUCEMENTS AND VOICEMAIL DATA: RECEIVE CONTROL PACKET SPECIFYING A PARTICULAR STREAM THAT IS TO BE PLAYED ON A PARTICULAR PORT
250
PBX SOFTWARE BROADCASTS PACKETS CONTAINING VOICE DATA TO ALL PEUS OVER PACKET BUS, EACH PACKET OF A PARTICULAR VOICEMAIL MESSAGE OR PRERECORDED MESSAGE HAVING A STREAM IDENTIFIER WITH ONE PACKET BEING TRANSMITTED EVERY 26 MSEC
252
FPGA AT PEU AND COPIES ANY PACKETS WITH CORRECT PEU ADDRESS OR A BROADCAST PEU ADDRESS THAT INDICATES ALL PORTS ARE SUPPOSED TO PROCESS THE MESSAGE INTO THE RECEIVE FIFO OF MC
254
MC RETRIEVES PACKETS OUT OF FIFO AND LOOKS AT TYPE FIELD TO DETERMINE IF IT IS PLAY DATA. IF SO, THEN THE MC LOOKS AT THE PORT ADDRESS. IF THE PORT ADDRESS IS A BROADCAST ADDRESS, THEN THE MC LOOKS AT THE STREAM ID AND COMPARES TO STREAM ID PREVIOUSLY IDENTIFIED IN CONROL MESSAGES FOR VARIOUS PORTS TO DETERMINE IF THERE ARE ANY MATCHES. MC WRITES VOICE DATA OF PAYLOAD SECTION INTO INPUT BUFFER OF DSP THAT CORRESPONDS TO ANY MATCHES OF STREAM IDS
256
IF THE PORT ADDRESS IS NOT A BROADCAST ADDRSS, THEN THE MC WRITES THE PAYLOAD DATA FROM THE PACKET INTO THE INPUT BUFFER OF THE DSP THAT CORRESPONDS TO THE PORT IDENTIFIED IN THE PORT ADDRESS
258

FIG. 7B

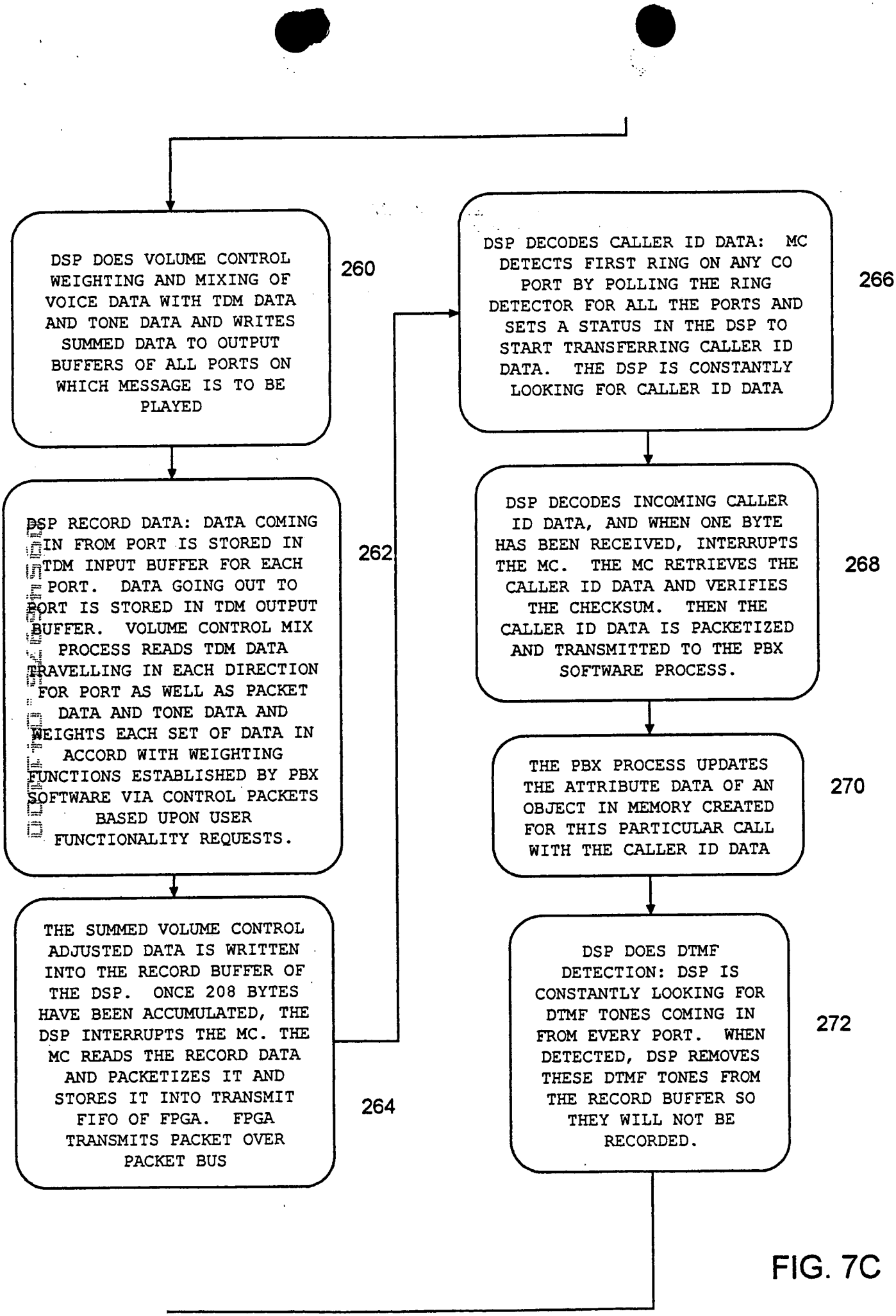

DSP DOES VOLUME CONTROL WEIGHTING AND MIXING OF VOICE DATA WITH TDM DATA AND TONE DATA AND WRITES SUMMED DATA TO OUTPUT BUFFERS OF ALL PORTS ON WHICH MESSAGE IS TO BE PLAYED
260
DSP RECORD DATA: DATA COMING IN FROM PORT IS STORED IN TDM INPUT BUFFER FOR EACH PORT. DATA GOING OUT TO PORT IS STORED IN TDM OUTPUT BUFFER. VOLUME CONTROL MIX PROCESS READS TDM DATA TRAVELLING IN EACH DIRECTION FOR PORT AS WELL AS PACKET DATA AND TONE DATA AND WEIGHTS EACH SET OF DATA IN ACCORD WITH WEIGHTING FUNCTIONS ESTABLISHED BY PBX SOFTWARE VIA CONTROL PACKETS BASED UPON USER FUNCTIONALITY REQUESTS.
262
THE SUMMED VOLUME CONTROL ADJUSTED DATA IS WRITTEN INTO THE RECORD BUFFER OF THE DSP. ONCE 208 BYTES HAVE BEEN ACCUMULATED, THE DSP INTERRUPTS THE MC. THE MC READS THE RECORD DATA AND PACKETIZES IT AND STORES IT INTO TRANSMIT FIFO OF FPGA. FPGA TRANSMITS PACKET OVER PACKET BUS
264
DSP DECODES CALLER ID DATA: MC DETECTS FIRST RING ON ANY CO PORT BY POLLING THE RING DETECTOR FOR ALL THE PORTS AND SETS A STATUS IN THE DSP TO START TRANSFERRING CALLER ID DATA. THE DSP IS CONSTANTLY LOOKING FOR CALLER ID DATA
266
DSP DECODES INCOMING CALLER ID DATA, AND WHEN ONE BYTE HAS BEEN RECEIVED, INTERRUPTS THE MC. THE MC RETRIEVES THE CALLER ID DATA AND VERIFIES THE CHECKSUM. THEN THE CALLER ID DATA IS PACKETIZED AND TRANSMITTED TO THE PBX SOFTWARE PROCESS.
268
THE PBX PROCESS UPDATES THE ATTRIBUTE DATA OF AN OBJECT IN MEMORY CREATED FOR THIS PARTICULAR CALL WITH THE CALLER ID DATA
270
DSP DOES DTMF DETECTION: DSP IS CONSTANTLY LOOKING FOR DTMF TONES COMING IN FROM EVERY PORT. WHEN DETECTED, DSP REMOVES THESE DTMF TONES FROM THE RECORD BUFFER SO THEY WILL NOT BE RECORDED.
272

FIG. 7C

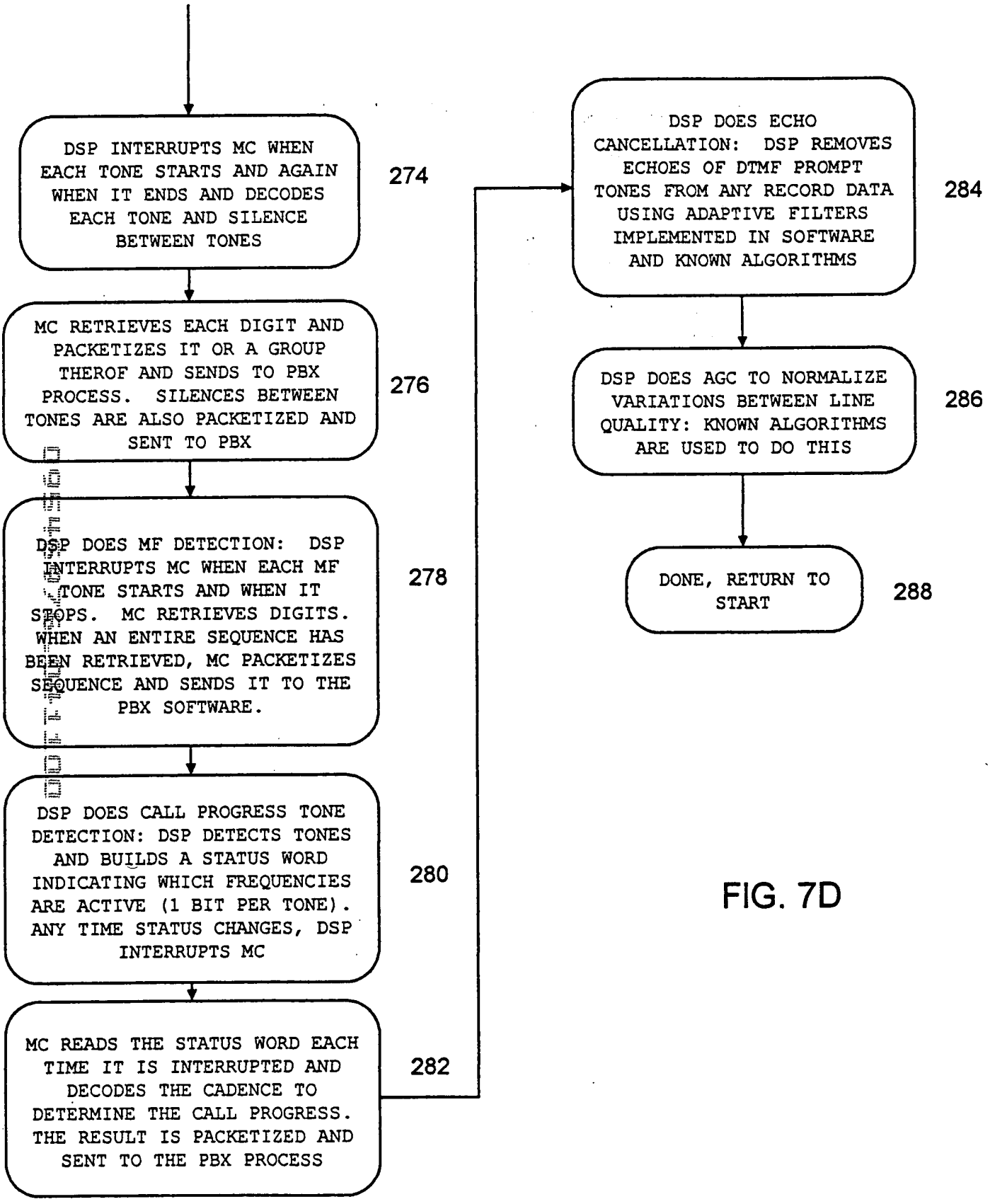

DSP INTERRUPTS MC WHEN EACH TONE STARTS AND AGAIN WHEN IT ENDS AND DECODES EACH TONE AND SILENCE BETWEEN TONES
274
MC RETRIEVES EACH DIGIT AND PACKETIZES IT OR A GROUP THEROF AND SENDS TO PBX PROCESS. SILENCES BETWEEN TONES ARE ALSO PACKETIZED AND SENT TO PBX
276
DSP DOES MF DETECTION: DSP INTERRUPTS MC WHEN EACH MF TONE STARTS AND WHEN IT STOPS. MC RETRIEVES DIGITS. WHEN AN ENTIRE SEQUENCE HAS BEEN RETRIEVED, MC PACKETIZES SEQUENCE AND SENDS IT TO THE PBX SOFTWARE.
278
DSP DOES CALL PROGRESS TONE DETECTION: DSP DETECTS TONES AND BUILDS A STATUS WORD INDICATING WHICH FREQUENCIES ARE ACTIVE (1 BIT PER TONE). ANY TIME STATUS CHANGES, DSP INTERRUPTS MC
280
MC READS THE STATUS WORD EACH TIME IT IS INTERRUPTED AND DECODES THE CADENCE TO DETERMINE THE CALL PROGRESS. THE RESULT IS PACKETIZED AND SENT TO THE PBX PROCESS
282
DSP DOES ECHO CANCELLATION: DSP REMOVES ECHOES OF DTMF PROMPT TONES FROM ANY RECORD DATA USING ADAPTIVE FILTERS IMPLEMENTED IN SOFTWARE AND KNOWN ALGORITHMS
284
DSP DOES AGC TO NORMALIZE VARIATIONS BETWEEN LINE QUALITY: KNOWN ALGORITHMS ARE USED TO DO THIS
286
DONE, RETURN TO START
288

FIG. 7D

MC-TELEPHONE INTERFACE PROCESSING FOR INCOMING CALL

MC RECEIVES CONFIGURATION DATA FROM PBX AT STARTUP AND SEND COMMAND TO DID SWITCH 202 OF EACH PORT TO SET FOR A CO PORT OR EXTENSION PHONE AS APPROPRIATE — 287

MC READS GROUND START/LOOP START CONFIGURATION STATUS AT STARTUP AND SENDS A COMMAND TO SWITCH 190 TO SET IT FOR THE PROPER SIGNALLING PROTOCOL — 289

MC POLLS LOOP CURRENT DETECTOR EVERY 10 MSEC TO READ STATUS. IF GET 2-3 STATUS WHICH ARE THE SAME, THEN THAT IS CONSIDERED TO BE THE NEW STATUS AND IS REPORTED BY PACKET TO PBX — 290

MC POLLS RING DETECTOR EVERY 2 MSEC. STATUS IS DEBOUNCED AND IS THEN REPORTED BY PACKET TO PBX — 292

MC COMMUNICATES DIGITAL DATA WITH EXTENSION PHONES: DATA TO BE SENT TO PHONE IS GATHERED FROM PACKETS SENT BY PBX. MC POLLS EXTENSION PHONES FOR DATA TO BE SENT BACK FROM PHONE BY ADDRESSING EACH ONE INDIVIDUALLY IN TURN. EXTENSION PHONE RESPONDS TO POLL BY SENDING ANY DATA IT HAS OR AN "ACK, NO DATA" MESSAGE. ANY DATA TO BE SENT TO PHONE IS SENT DURING TIMES WHEN PHONE IS NOT BEING POLLED — 294

IF THE PHONE WHICH WAS POLLED DOES NOT RESPOND FOR N CONSECUTIVE POLLS, THE MC MARKS PCOMM FOR THAT PHONE AS DOWN. ANOTHER PROCESS RETRIES THE DOWNED PORTS EVERY SECOND TO DETERMINE IF THEY HAVE COME BACK UP YET. THE TABLE OF WHICH PORTS HAVE PCOMM STATUS UP OR DOWN IS REPORTED BY PACKETS TO THE PBX PROCESS — 296

PORT CONFIGURATION PROCESS PERIODICALLY READS MANUAL SWITCH 206 OF EACH PORT TO DETERMINE IF THERE HAS BEEN ANY CONFIGURATION CHANGE — 298

IF ANY CONFIGURATION CHANGE HAS HAPPENED, A PACKET IS SENT TO THE PBX PROCESS SIGNALLING THE CHANGED CONFIGURATION. — 300

MONITOR FOR INCOMING DID CALL ON ALL CO PORTS CONFIGURED FOR DID:MC EXAMINES STATUS OF LOOP CURRENT DETECTION AND RING STATUS AND DRAWS CONCLUSION AS TO WHETHER A DID INCOMING CALL IS READY TO BE SENT BY CO — 302

FIG 8A

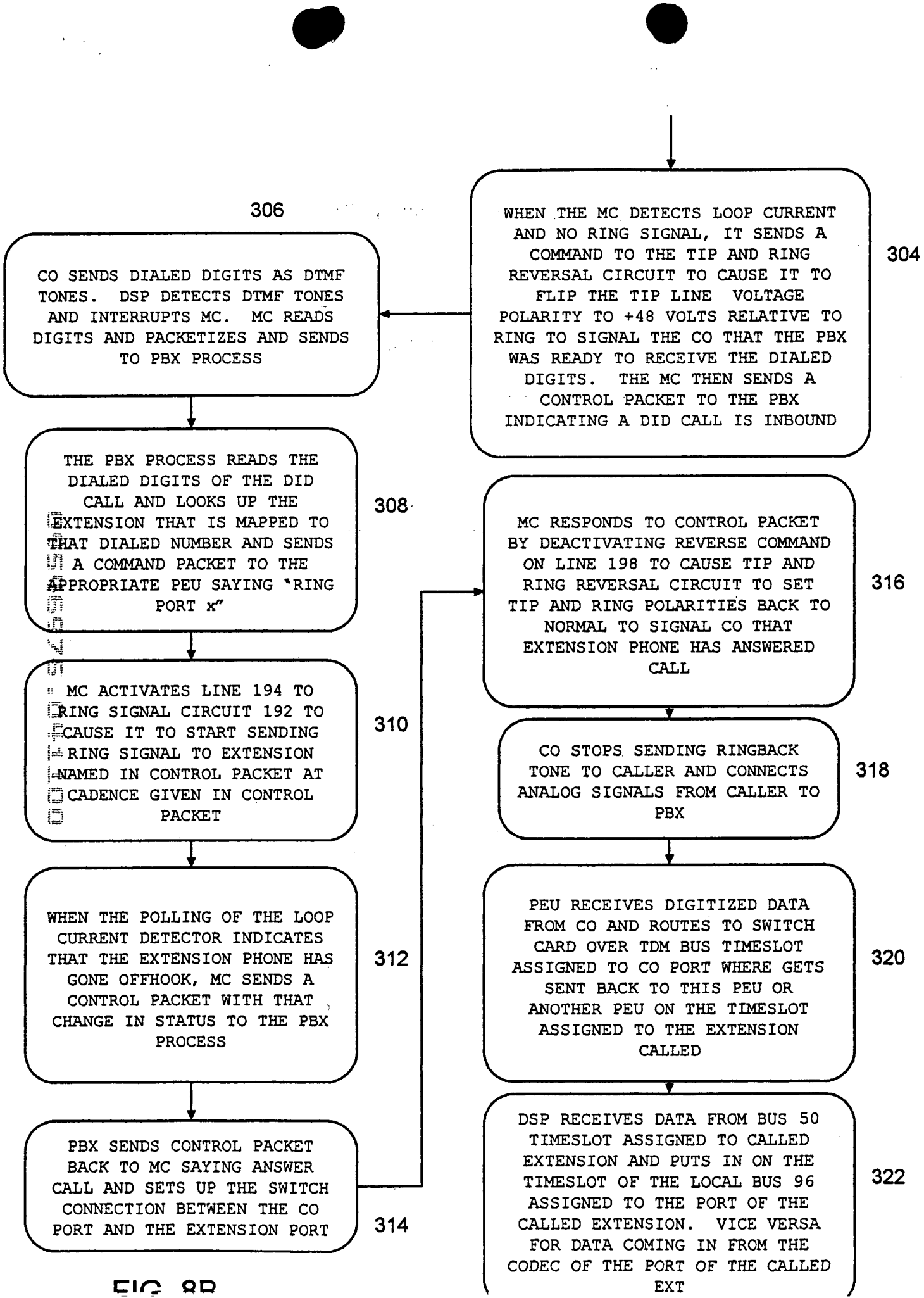

WHEN THE MC DETECTS LOOP CURRENT AND NO RING SIGNAL, IT SENDS A COMMAND TO THE TIP AND RING REVERSAL CIRCUIT TO CAUSE IT TO FLIP THE TIP LINE VOLTAGE POLARITY TO +48 VOLTS RELATIVE TO RING TO SIGNAL THE CO THAT THE PBX WAS READY TO RECEIVE THE DIALED DIGITS. THE MC THEN SENDS A CONTROL PACKET TO THE PBX INDICATING A DID CALL IS INBOUND
304
306
CO SENDS DIALED DIGITS AS DTMF TONES. DSP DETECTS DTMF TONES AND INTERRUPTS MC. MC READS DIGITS AND PACKETIZES AND SENDS TO PBX PROCESS
THE PBX PROCESS READS THE DIALED DIGITS OF THE DID CALL AND LOOKS UP THE EXTENSION THAT IS MAPPED TO THAT DIALED NUMBER AND SENDS A COMMAND PACKET TO THE APPROPRIATE PEU SAYING "RING PORT x"
308
MC ACTIVATES LINE 194 TO RING SIGNAL CIRCUIT 192 TO CAUSE IT TO START SENDING RING SIGNAL TO EXTENSION NAMED IN CONTROL PACKET AT CADENCE GIVEN IN CONTROL PACKET
310
WHEN THE POLLING OF THE LOOP CURRENT DETECTOR INDICATES THAT THE EXTENSION PHONE HAS GONE OFFHOOK, MC SENDS A CONTROL PACKET WITH THAT CHANGE IN STATUS TO THE PBX PROCESS
312
PBX SENDS CONTROL PACKET BACK TO MC SAYING ANSWER CALL AND SETS UP THE SWITCH CONNECTION BETWEEN THE CO PORT AND THE EXTENSION PORT
314
MC RESPONDS TO CONTROL PACKET BY DEACTIVATING REVERSE COMMAND ON LINE 198 TO CAUSE TIP AND RING REVERSAL CIRCUIT TO SET TIP AND RING POLARITIES BACK TO NORMAL TO SIGNAL CO THAT EXTENSION PHONE HAS ANSWERED CALL
316
CO STOPS SENDING RINGBACK TONE TO CALLER AND CONNECTS ANALOG SIGNALS FROM CALLER TO PBX
318
PEU RECEIVES DIGITIZED DATA FROM CO AND ROUTES TO SWITCH CARD OVER TDM BUS TIMESLOT ASSIGNED TO CO PORT WHERE GETS SENT BACK TO THIS PEU OR ANOTHER PEU ON THE TIMESLOT ASSIGNED TO THE EXTENSION CALLED
320
DSP RECEIVES DATA FROM BUS 50 TIMESLOT ASSIGNED TO CALLED EXTENSION AND PUTS IN ON THE TIMESLOT OF THE LOCAL BUS 96 ASSIGNED TO THE PORT OF THE CALLED EXTENSION. VICE VERSA FOR DATA COMING IN FROM THE CODEC OF THE PORT OF THE CALLED EXT
322

FIG. 8B

MICROCONTROLLER-TEL INTERFACE PROCESSING FOR OUTGOING CALL

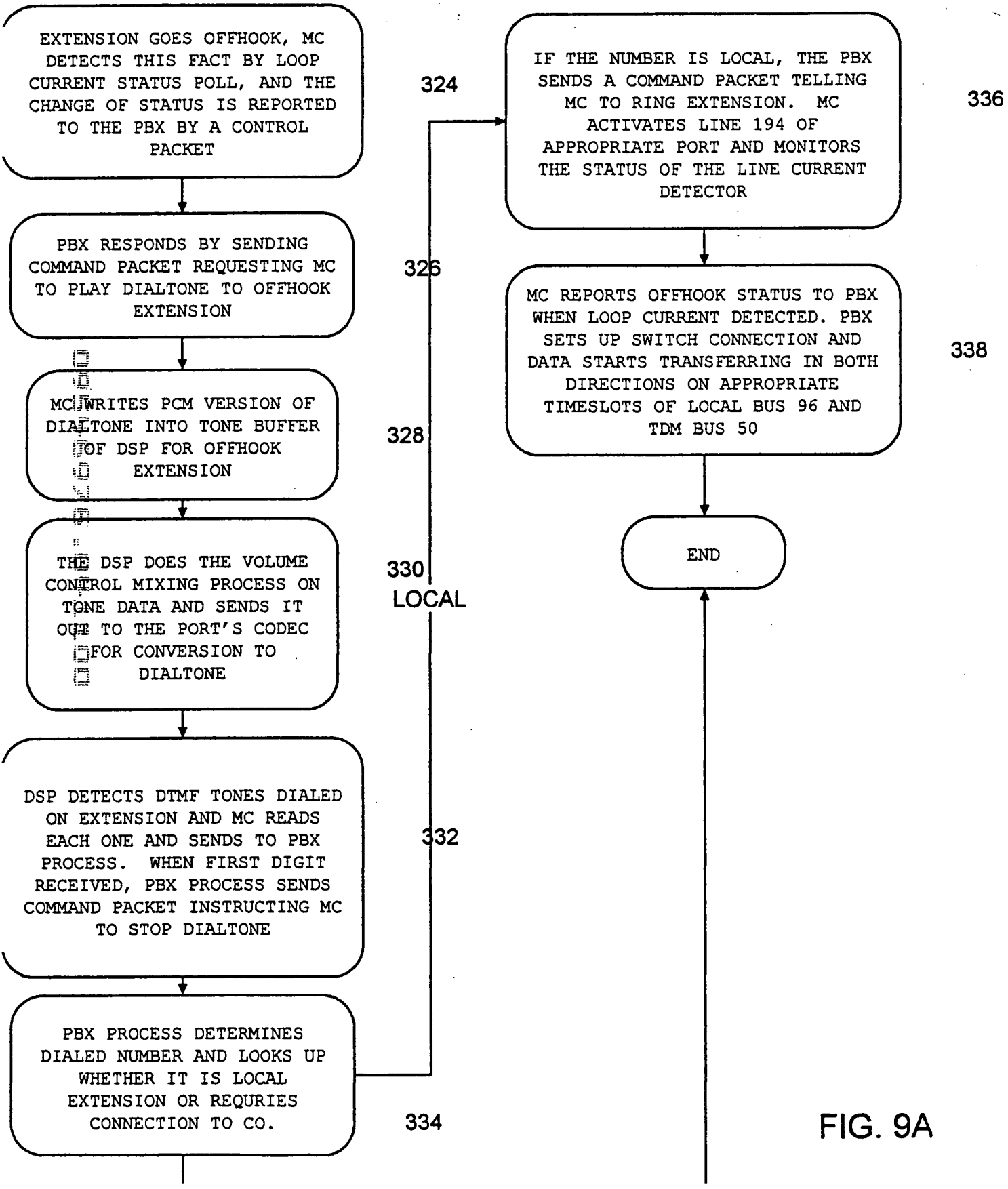


FIG. 9A

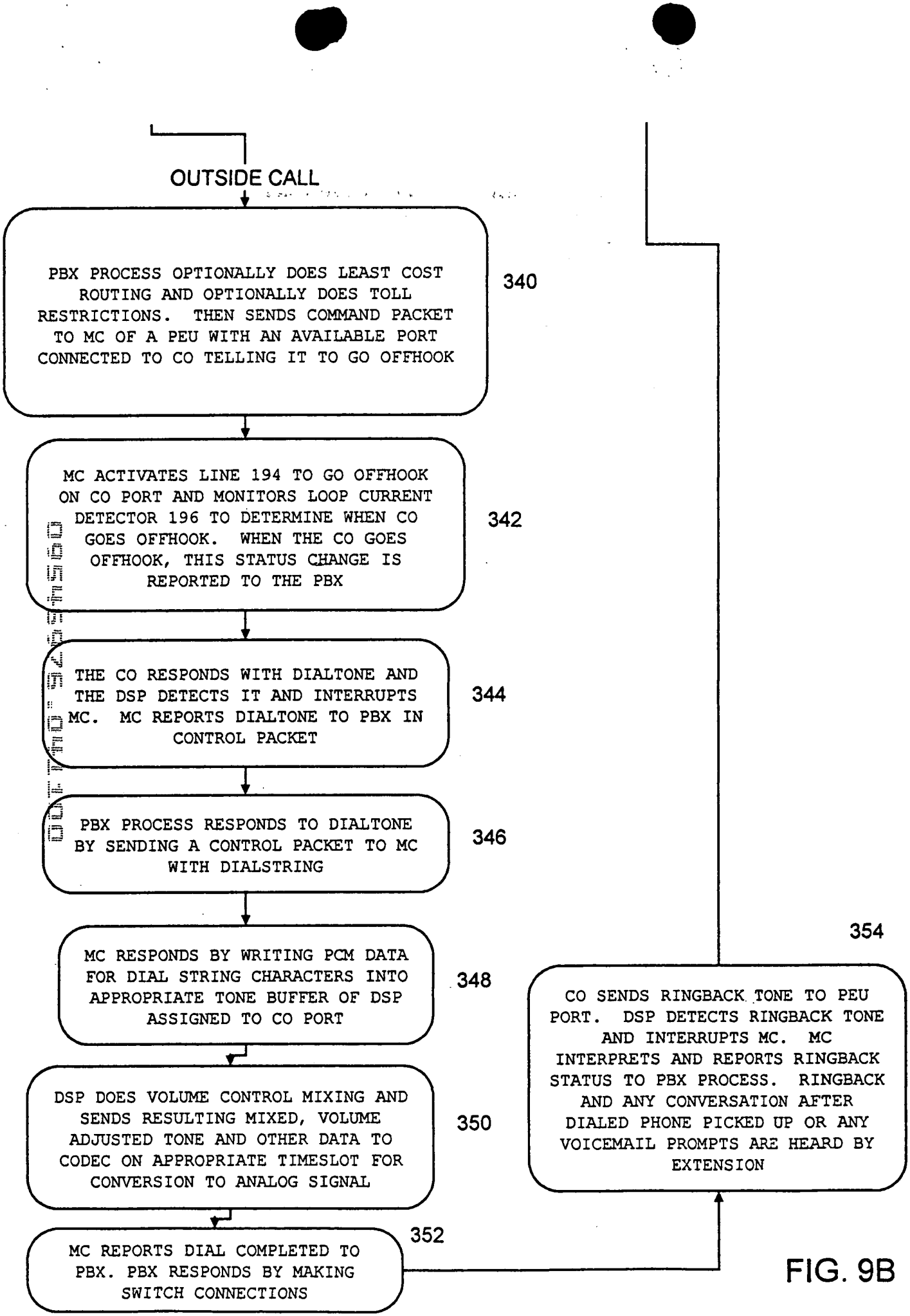

OUTSIDE CALL
PBX PROCESS OPTIONALLY DOES LEAST COST ROUTING AND OPTIONALLY DOES TOLL RESTRICTIONS. THEN SENDS COMMAND PACKET TO MC OF A PEU WITH AN AVAILABLE PORT CONNECTED TO CO TELLING IT TO GO OFFHOOK
340
MC ACTIVATES LINE 194 TO GO OFFHOOK ON CO PORT AND MONITORS LOOP CURRENT DETECTOR 196 TO DETERMINE WHEN CO GOES OFFHOOK. WHEN THE CO GOES OFFHOOK, THIS STATUS CHANGE IS REPORTED TO THE PBX
342
THE CO RESPONDS WITH DIALTONE AND THE DSP DETECTS IT AND INTERRUPTS MC. MC REPORTS DIALTONE TO PBX IN CONTROL PACKET
344
PBX PROCESS RESPONDS TO DIALTONE BY SENDING A CONTROL PACKET TO MC WITH DIALSTRING
346
MC RESPONDS BY WRITING PCM DATA FOR DIAL STRING CHARACTERS INTO APPROPRIATE TONE BUFFER OF DSP ASSIGNED TO CO PORT
348
DSP DOES VOLUME CONTROL MIXING AND SENDS RESULTING MIXED, VOLUME ADJUSTED TONE AND OTHER DATA TO CODEC ON APPROPRIATE TIMESLOT FOR CONVERSION TO ANALOG SIGNAL
350
MC REPORTS DIAL COMPLETED TO PBX. PBX RESPONDS BY MAKING SWITCH CONNECTIONS
352
354
CO SENDS RINGBACK TONE TO PEU PORT. DSP DETECTS RINGBACK TONE AND INTERRUPTS MC. MC INTERPRETS AND REPORTS RINGBACK STATUS TO PBX PROCESS. RINGBACK AND ANY CONVERSATION AFTER DIALED PHONE PICKED UP OR ANY VOICEMAIL PROMPTS ARE HEARD BY EXTENSION

FIG. 9B

TEU PROCESSING FOR AN INCOMING T1 CALL

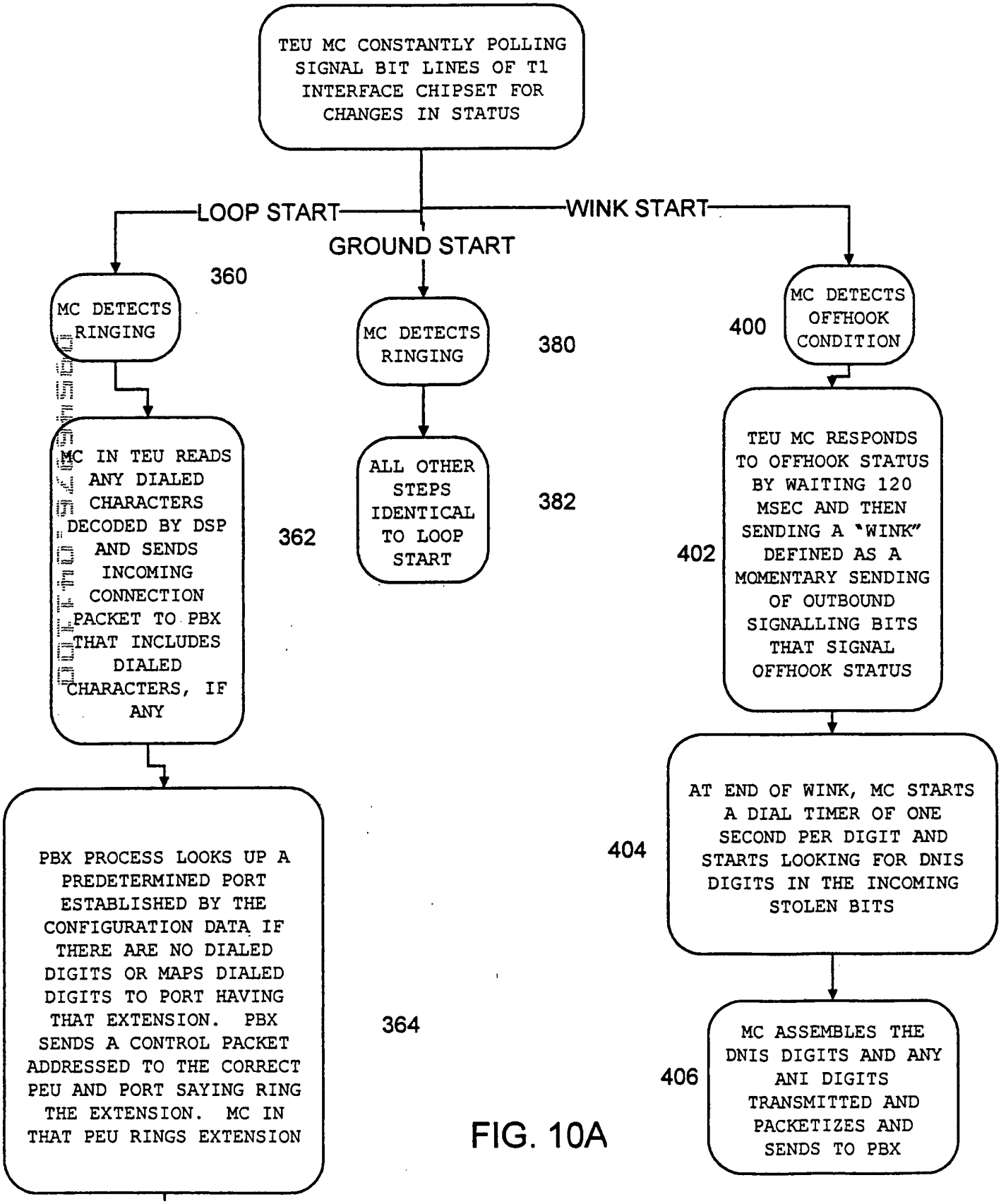


FIG. 10A

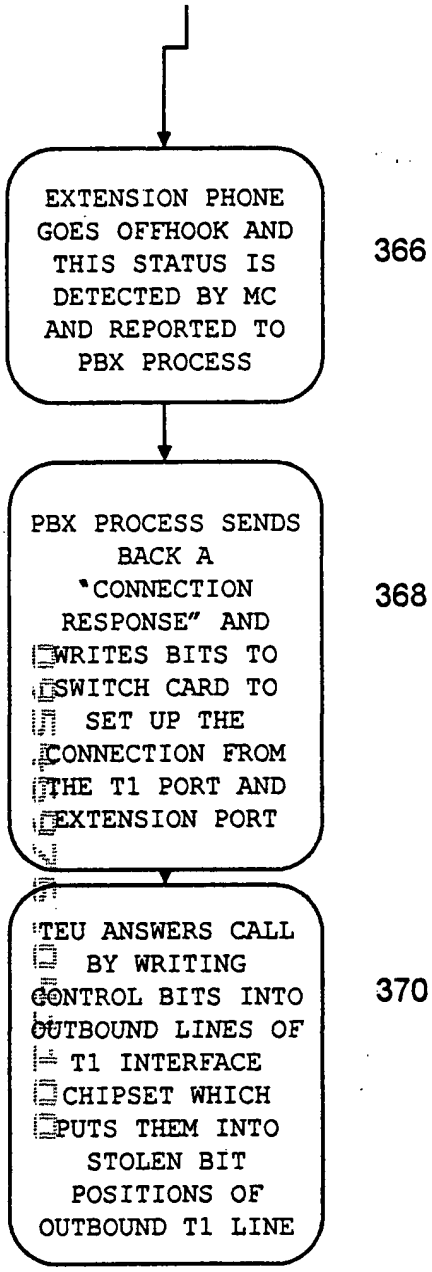

EXTENSION PHONE GOES OFFHOOK AND THIS STATUS IS DETECTED BY MC AND REPORTED TO PBX PROCESS
366
PBX PROCESS SENDS BACK A "CONNECTION RESPONSE" AND WRITES BITS TO SWITCH CARD TO SET UP THE CONNECTION FROM THE T1 PORT AND EXTENSION PORT
368
TEU ANSWERS CALL BY WRITING CONTROL BITS INTO OUTBOUND LINES OF T1 INTERFACE CHIPSET WHICH PUTS THEM INTO STOLEN BIT POSITIONS OF OUTBOUND T1 LINE
370

FIG. 10B

T1 TEU PROCESSING FOR OUTBOUND CALL

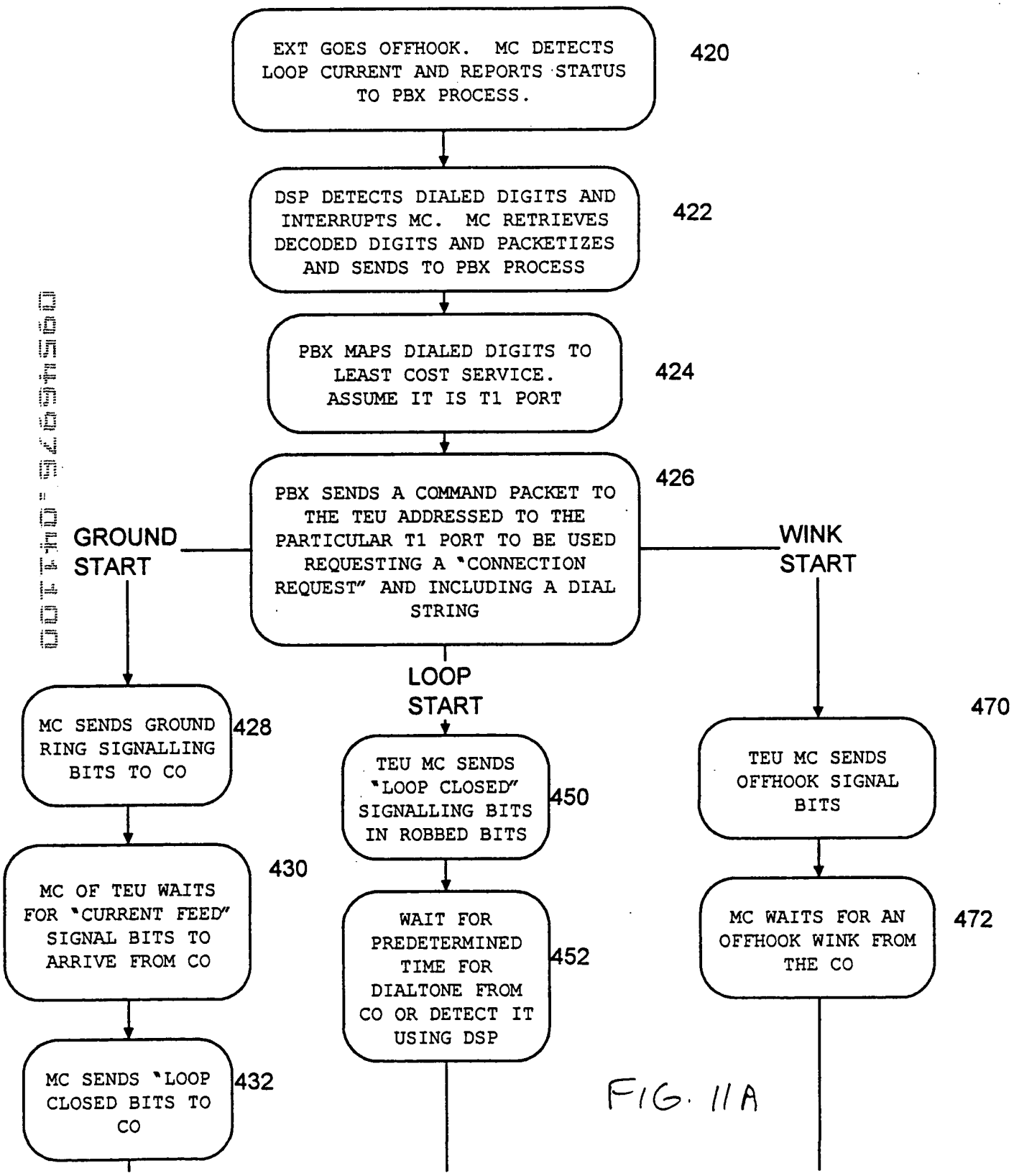


FIG. 11A

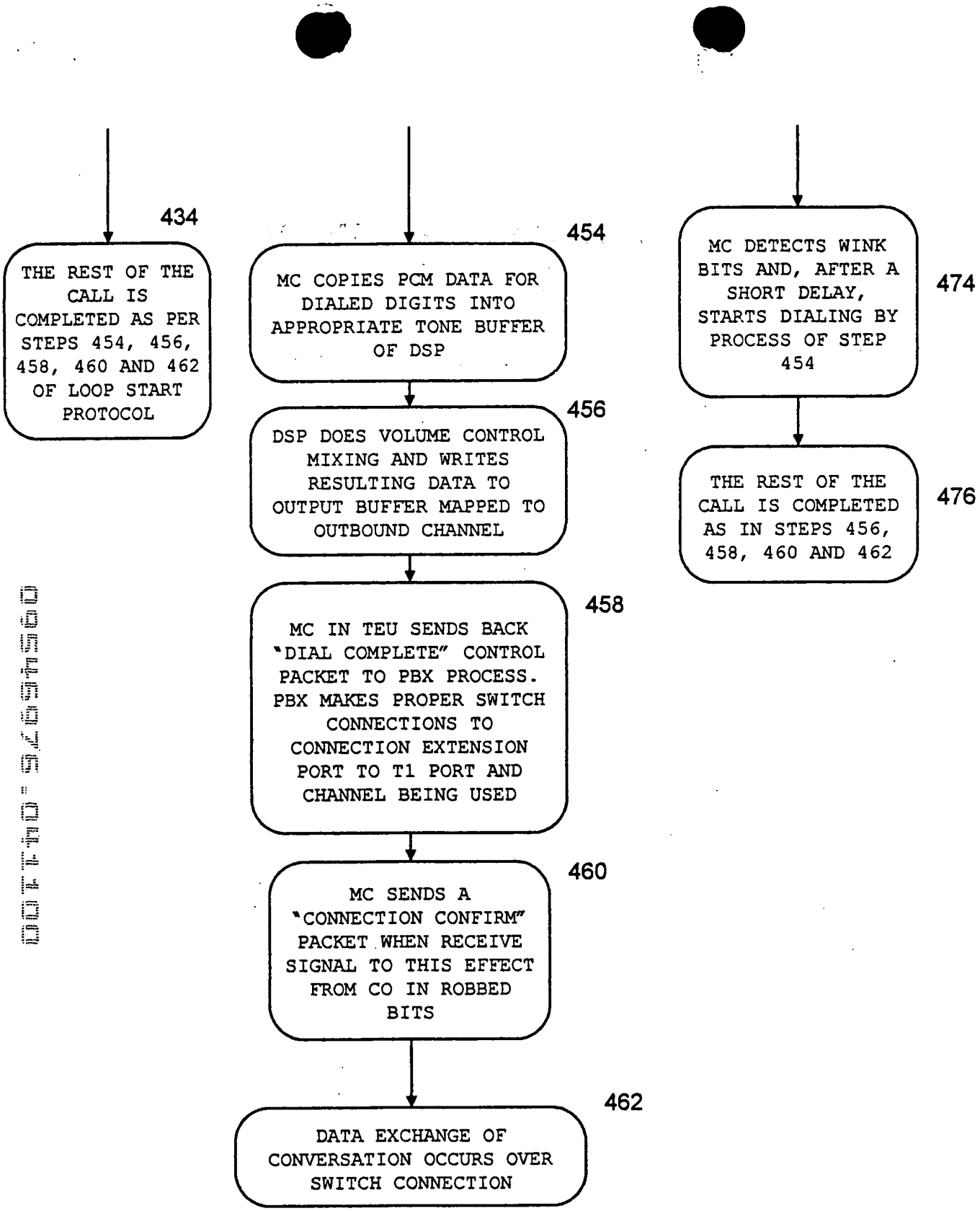

434
THE REST OF THE CALL IS COMPLETED AS PER STEPS 454, 456, 458, 460 AND 462 OF LOOP START PROTOCOL
454
MC COPIES PCM DATA FOR DIALED DIGITS INTO APPROPRIATE TONE BUFFER OF DSP
456
DSP DOES VOLUME CONTROL MIXING AND WRITES RESULTING DATA TO OUTPUT BUFFER MAPPED TO OUTBOUND CHANNEL
458
MC IN TEU SENDS BACK "DIAL COMPLETE" CONTROL PACKET TO PBX PROCESS. PBX MAKES PROPER SWITCH CONNECTIONS TO CONNECTION EXTENSION PORT TO T1 PORT AND CHANNEL BEING USED
460
MC SENDS A "CONNECTION CONFIRM" PACKET WHEN RECEIVE SIGNAL TO THIS EFFECT FROM CO IN ROBBED BITS
462
DATA EXCHANGE OF CONVERSATION OCCURS OVER SWITCH CONNECTION
MC DETECTS WINK BITS AND, AFTER A SHORT DELAY, STARTS DIALING BY PROCESS OF STEP 454
474
THE REST OF THE CALL IS COMPLETED AS IN STEPS 456, 458, 460 AND 462
476

FIG. 11B

SWITCH CARD DSP CONFERENCING PROCESS

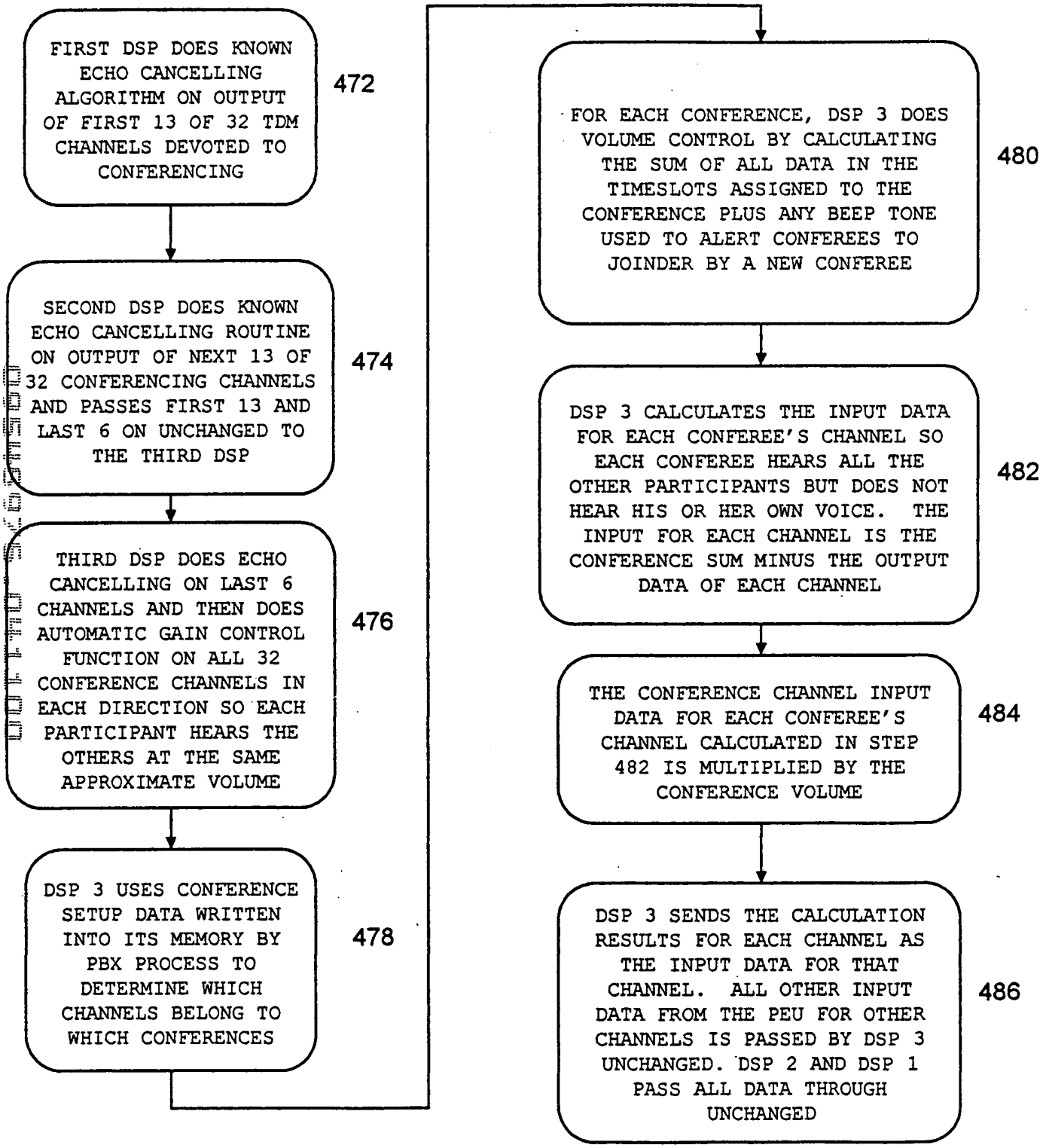


FIG. 12

ANALOG LOOP START PROTOCOL PROCESS - CO ORIGINATES CALL

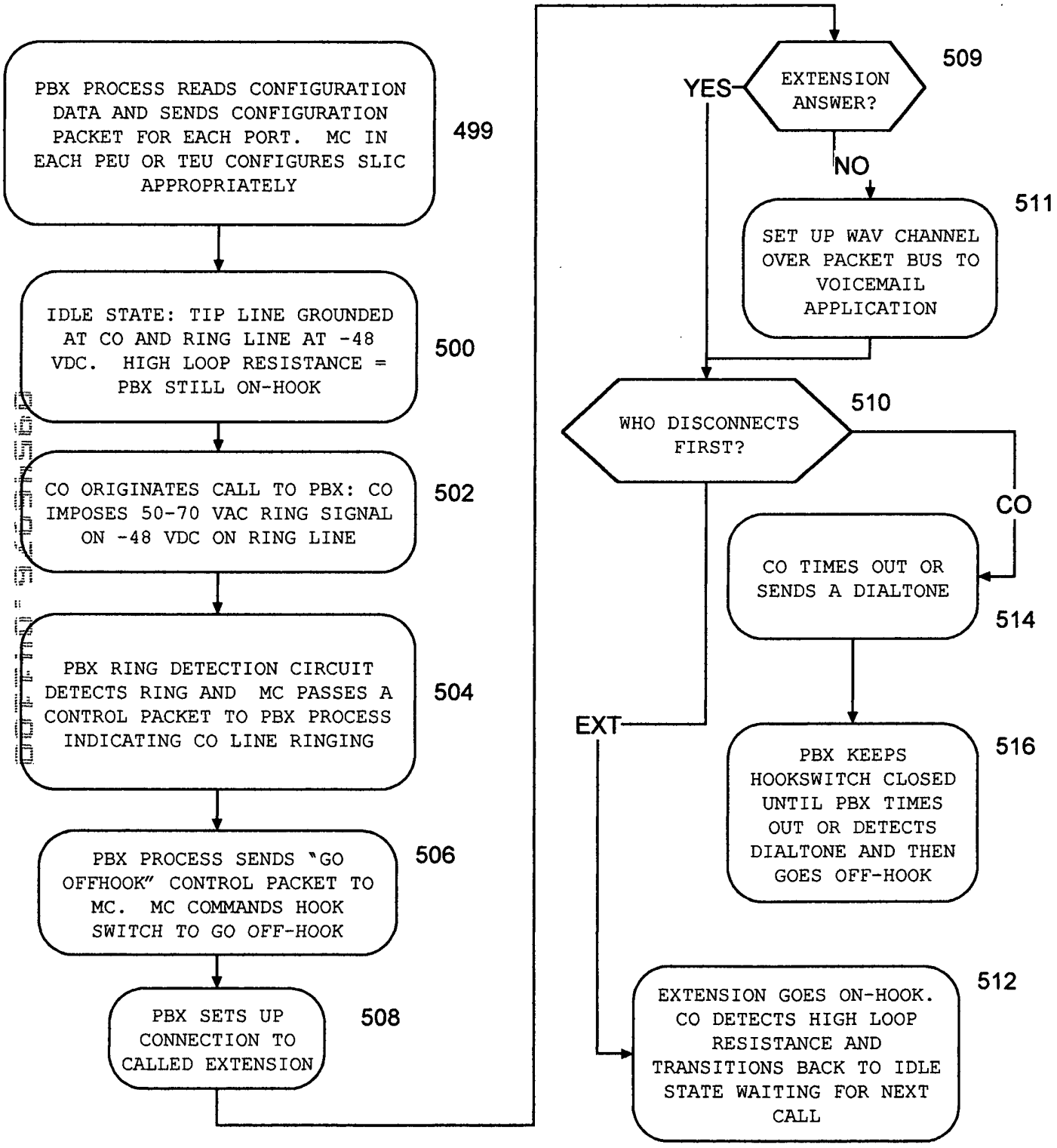


FIGURE 13

ACER/my doc/ DIC101PF13.cid

ANALOG LOOP START PROTOCOL PROCESS - PBX INITIATES THE CAL

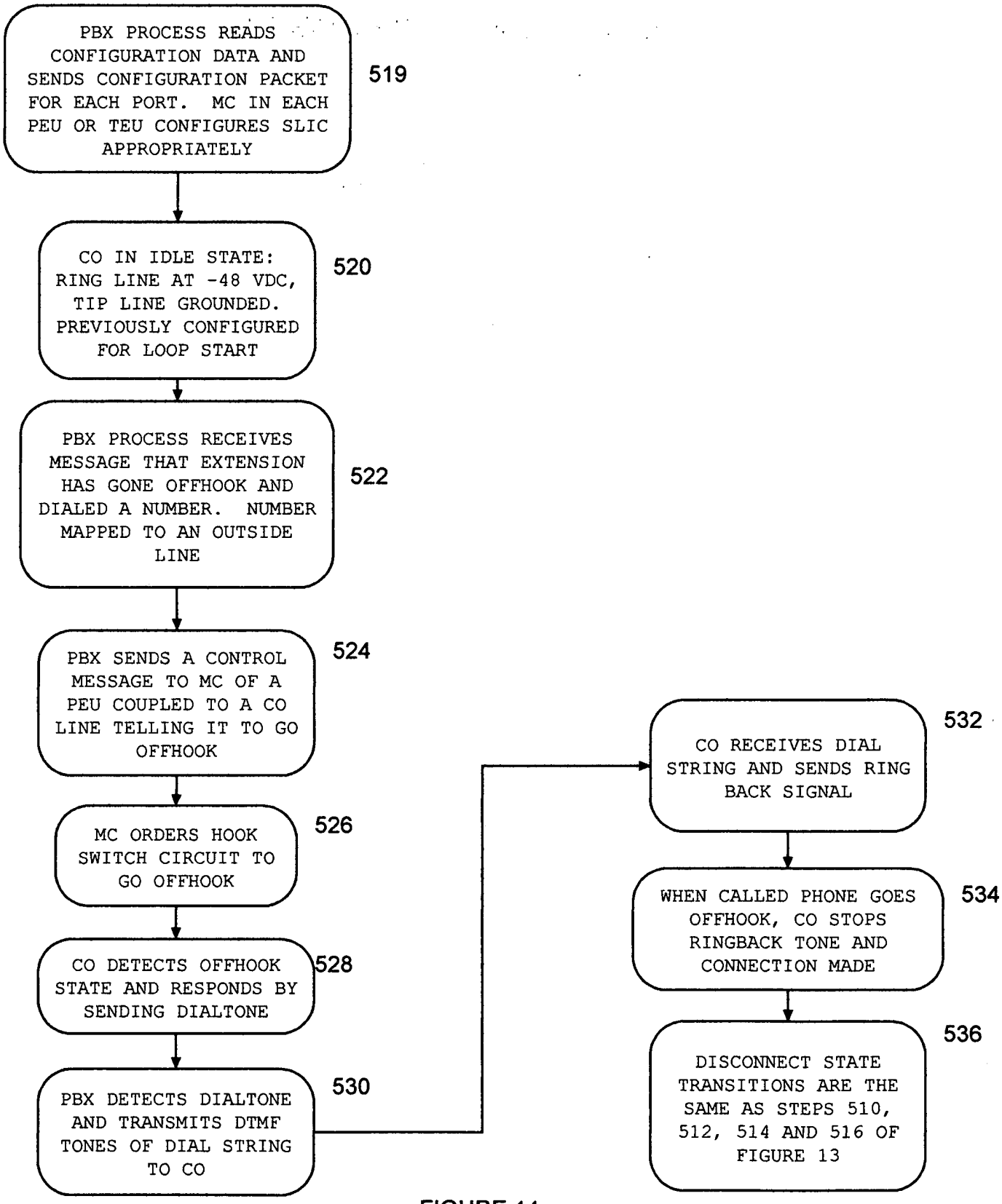


FIGURE 14

Docket No. 2005-0135

GROUND START SIGNALLING PROTOCOL - ANALOG CO LINE - CO ORIGINATES CAL

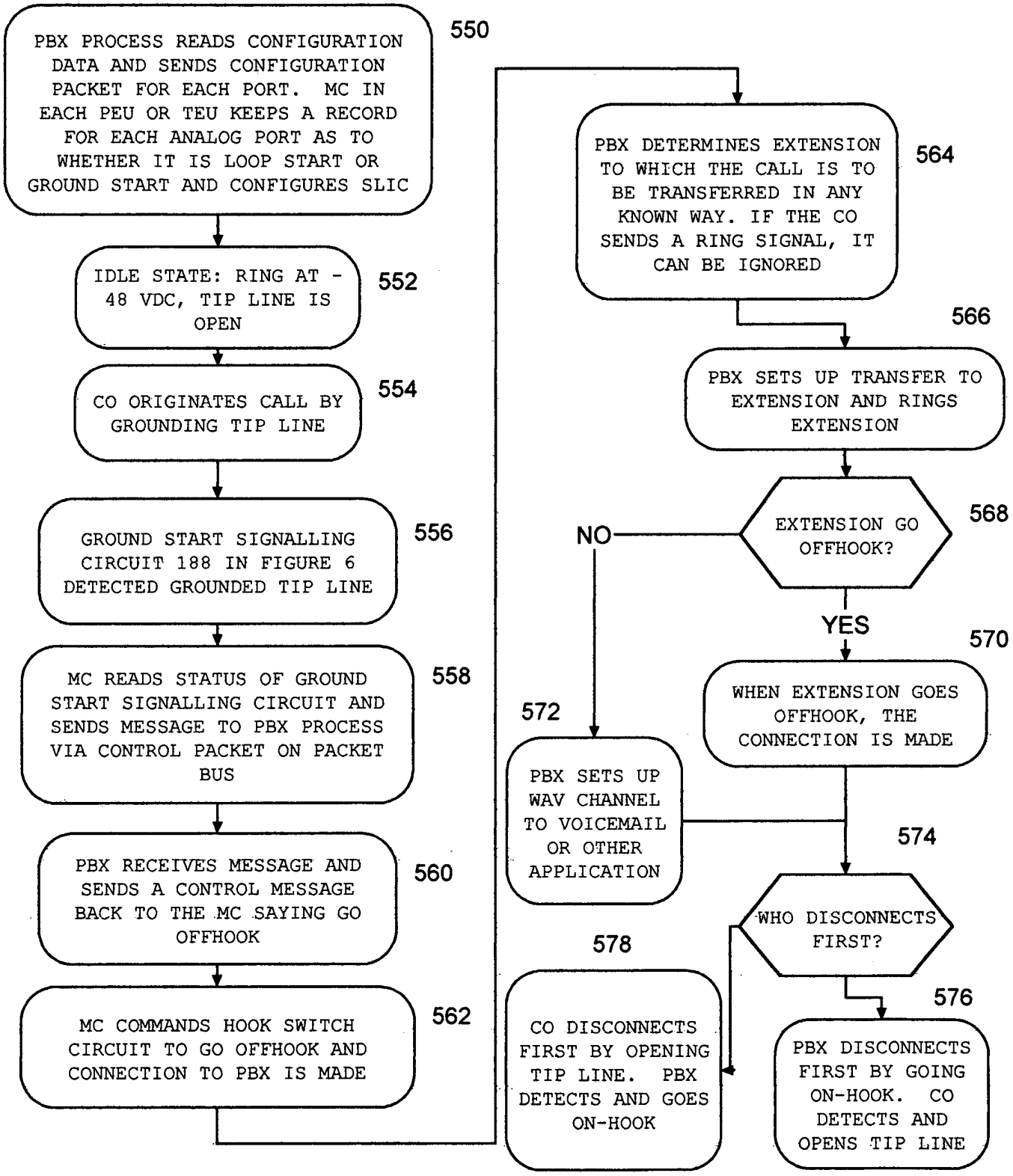


FIGURE 15

GROUND START SIGNALLING PROTOCOL - ANALOG CO LINE - PBX ORIGINATES CAL

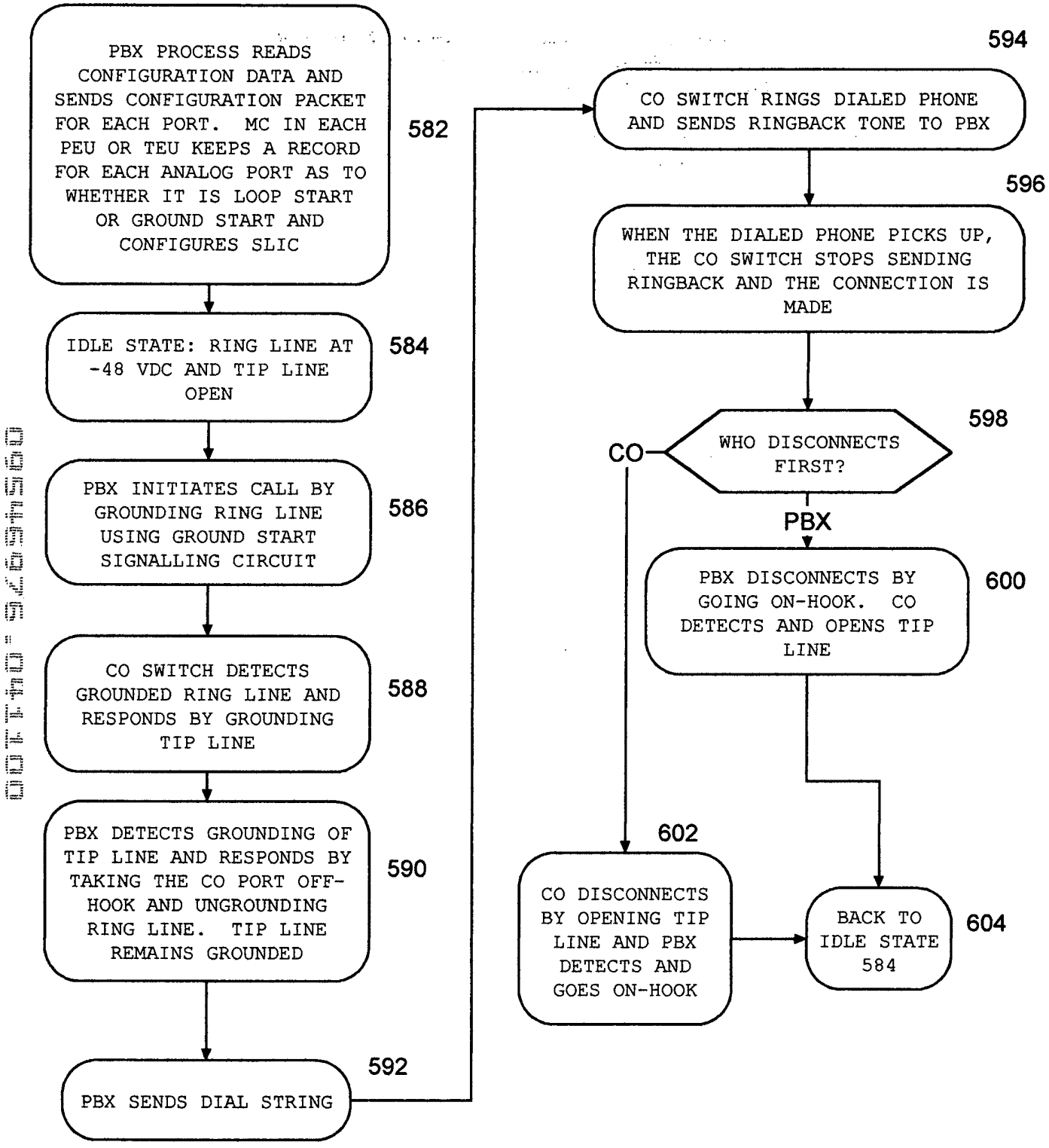


FIGURE 16

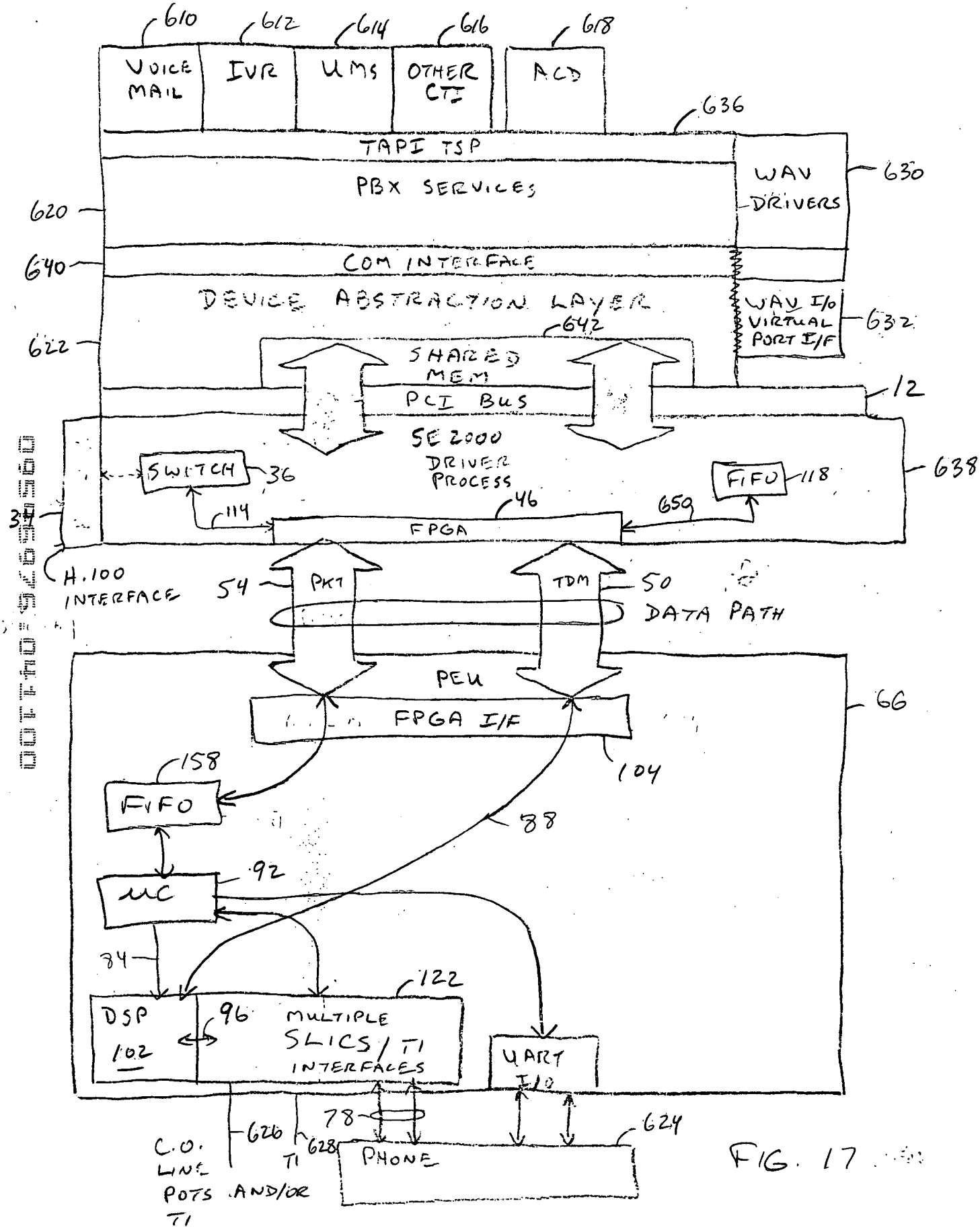
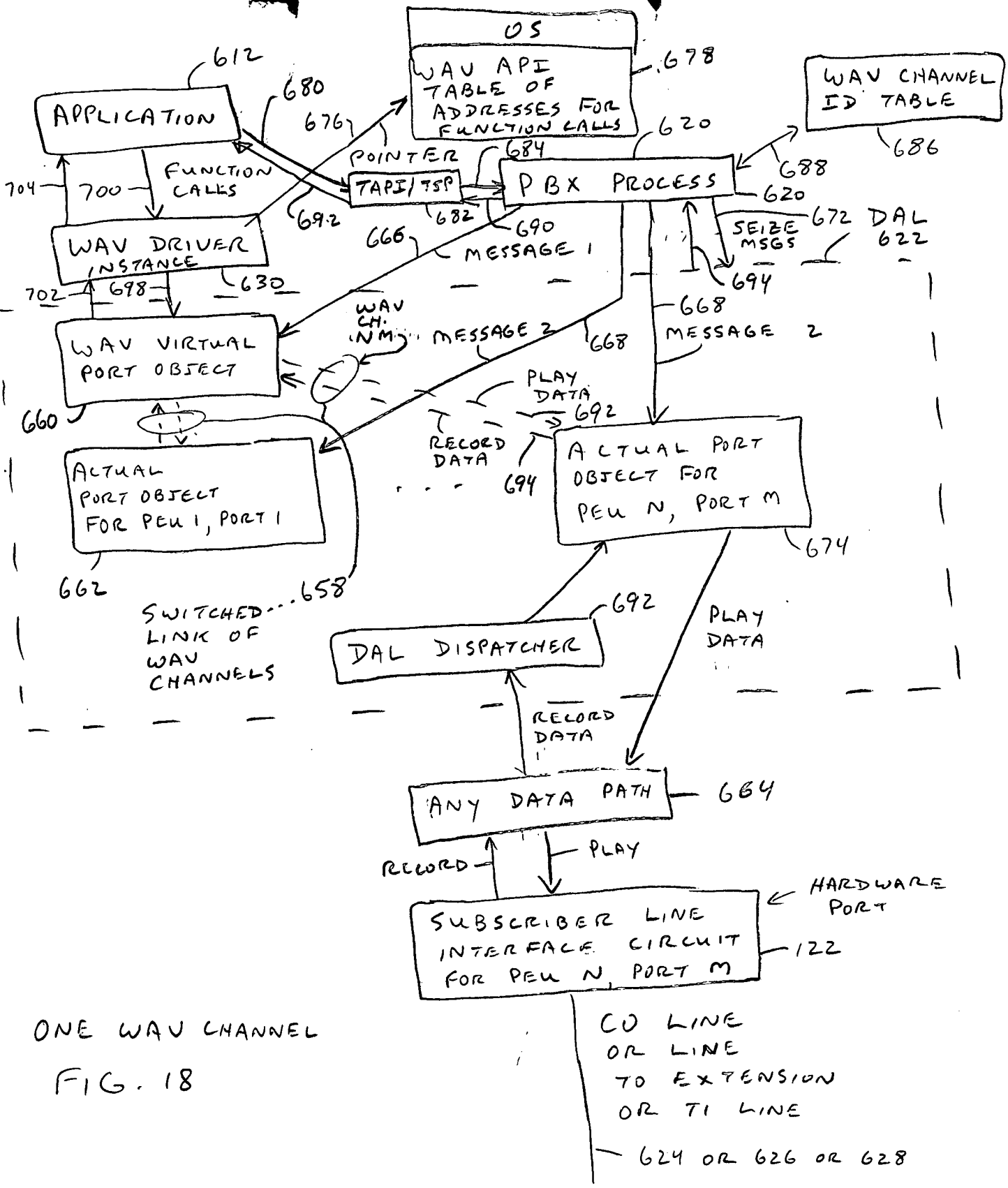

610
612
614
616
618
VOICE MAIL
IVR
UMS
OTHER CTI
ACD
636
TAPI TSP
PBX SERVICES
WAV DRIVERS
630
620
640
COM INTERFACE
DEVICE ABSTRACTION LAYER
WAV I/O VIRTUAL PORT I/F
632
622
642
SHARED MEM
PCI BUS
12
SE2000 DRIVER PROCESS
638
SWITCH
36
FIFO
118
114
46
659
FPGA
H.100 INTERFACE
54
PKT
TDM
50
DATA PATH
PEU
FPGA I/F
66
104
158
FIFO
88
92
uC
84
122
DSP 102
96
MULTIPLE SLICS/T1 INTERFACES
UART I/O
78
624
626
628
C.O. LINE POTS AND/OR T1
T1
PHONE

FIG. 17



ONE WAV CHANNEL

FIG. 18